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(54) **MOLDING SAND APPROPRIATE FOR THE FABRICATION OF CORES AND MOLDS**

(57) The molding sand comprises hollow microspheres of aluminum silicate, preferably with an aluminum content between 15 and 45% by weight, a wall thickness between 3 and 10% of the particle diameter and a particle size between 10 and 350 μm. These sands are useful to manufacture low density cores with good "veining" and penetration characteristics, moreover maintaining the mechanical properties of the core obtained. These cores are useful in the manufacture of iron casting.

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Description

FIELD OF THE INVENTION

This invention is related to the manufacture of iron casting and, specifically, it refers to a molding sand for casting, suitable for manufacturing cores and chill molds, incorporating hollow microspheres of aluminum silicate.

BACKGROUND OF THE INVENTION

The iron casting obtained by using cores manufactured with molding sand, generally have a series of defects in their shape, such that it is necessary to subject them to machining to obtain a dimensionally correct piece. These defects are produced due to the heating the core suffers due to the effect of the molten metal poured over it, provoking its expansion and hence, the appearance of fissures on its surface. The molten metal penetrates these fissures, hence forming a kind of partition wall or laminas on the surface of the piece obtained. This undesired effect is known "veining" or "rat's tail".

At present, the cores are manufactured using molding sands and gas- or heat-cured resins, or self-curing resins, together with additives destined to improve the characteristics of the piece obtained.

To prevent the formation of "veining", a series of techniques are known and used, such as:

- The use of iron oxide as an additive.

The iron oxides used as additives, are destined to minimize the problems created by the expansion of the silica contained in the sands, being used for such a purpose red, black, yellow iron oxides or iron oxide from Sierra Leone, which are incorporated to the mixture in percentages varying from 1 to 3%. These oxides act as a factor for the formation of feyalite, such that the "veining" is minimized during the formation of the fissure. Nevertheless, this technique besides not eliminating "veining" in some cases, has as a disadvantage that the iron oxide reduces the mechanical resistance of the core and moreover the formation of feyalite increases the tendency to penetration, causing the external surface of the piece obtained to present irregularities, which should be treated later.

- Use of wood flours and coal powder.

According to this technique, wood flour or coal powders are added in proportions varying from 1 to 3%. These flours burn during melting, hence leaving free gaps distributed throughout the volume of the core, permitting that the expansion of the silica is produced in these gaps without the need to increase the external size, hence avoiding the appearance of fissures provoking "veining". The main disadvantage of this technique is that when the flours burn, a large amount of gas is produced which, on circulating, may result in dimensional problems in the pieces obtained. Likewise, with this type of additive, a reduction in the mechanical resistance of the cores is produced.

- Use of titanium oxide as an additive

This new technique described in the US Patent Number 4.735.973, is based on the use of titanium oxide additives, the additive being present at percentages varying between 0.5 and 5% of the total amount of sand and said additive containing between 15 and 95% titanium oxide. With this technique, thermal expansion is reduced, preventing, as a result "veining", maintaining the mechanical resistance of the cores and not producing an increase in gas production. The disadvantage of this technique lies in the fact that the cores obtained possesses a certain tendency to penetration, it being necessary to apply paints or other treatments on the surface of the cores obtained before proceeding to melting the piece.

- Use of natural sands of low expansion

This new technique uses for the formation of the core, special sands of the rounded of sub-angular silica type, chromite sands, zirconium sands and olivine sands, which, due to their different degrees of thermal expansion, result in the reduction of "veining", and even to its total elimination. The basic disadvantage of this technique is the high cost of this type of sand, with the consequent increase in the cost to obtain the cores.

- Use of electrofused sands of low expansion

According to this technique, the silica sand normally used for the manufacture of cores is melted in electric ovens,

until obtaining a kind of paste without expansion capacity. Then, the paste obtained is ground until obtaining a sand powder which is mixed approximately at 50% with silica sand. In this way, the expansion of the core is avoided, since the powder obtained from the silica paste does not have a capacity for expansion and hence, neither produces fissures nor the corresponding veining. The basic disadvantage of this technique is the greater complexity of the production process, which makes the final cost to obtain the cores more expensive.

As may be appreciated, the techniques normally used to prevent the formation of "veining" consist either in the use of additives (iron oxide, titanium oxide, wood flours and coal powder) or in the use of special sands (natural sands of low expansion or electrofused sands of low expansion).

Now it has been found that it is possible to improve the quality of the iron casting by using cores or molds manufactured with molding sands incorporating hollow microspheres of aluminum silicate.

As a result, a purpose of this invention comprises a molding sand for casting which incorporates hollow microspheres of aluminum silicate.

An additional purpose of this invention comprises a process to manufacture cores or chill molds including the use of the molding sand indicated above. The resulting cores and molds also comprise a purpose of this invention.

Another additional purpose of this invention comprises a process to manufacture iron casting including the use of the cores or molds mentioned above. The resulting iron casting also comprises a purpose of this invention.

SUMMARY OF THE INVENTION

The invention provides a molding sand for casting which incorporates hollow microspheres of aluminum silicate in an amount between 1 and 30% by weight with respect to the total amount of molding sand.

The molding sand, purpose of this invention, is suitable to manufacture cores and chill molds which, in turn, may be used in the manufacture of iron casting.

The use of hollow microspheres of aluminum silicate prevents the appearance of fissures during core expansion, but without increasing gas production and maintaining the mechanical properties of the core obtained. During melting of the piece, the expansion of the silica in the molding sand does not cause an increase of the core, but the expansion is absorbed by the internal spaces of the hollow microspheres, by which the appearance of fissures on the core surface is totally prevented and, as a result, "veining".

With the molding sand of the invention, cores or molds are obtained of lesser density, by which gas production is reduced, but without decreasing its mechanical resistance. Likewise, the penetration of the piece obtained is reduced, due to the fact that the hollow microspheres of aluminum silicate cover the interstitial spaces of the core producing an effect similar to that of paint, improving the surface of the piece obtained. Therefore, the quality of the resulting iron casting is improved due to the reduction of the defects caused by core expansion and gas production.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a bar diagram in which the "veining" effect is seen for different techniques of core shaping, position 04 corresponding to the technique based on the use of a molding sand of the invention containing 10% by weight, of hollow microspheres of aluminum silicate.

Figure 2 shows a bar diagram in which the mechanical resistance obtained is seen according to the different techniques of core manufacture, the position 04 corresponding to the technique based on the use of a molding sand of the invention containing 10% by weight of hollow microspheres of aluminum silicate.

Figure 3 shows a bar diagram in which the density of the cores obtained is shown, according to the different manufacturing techniques.

Figure 4 shows a comparative diagram of "veining" and penetration obtained with molding sands containing hollow microspheres of aluminum silicate (invention) and molding sands containing titanium oxide according the US patent 4.735.973.

Figure 5 shows a bar diagram in which the tensile strength of cores obtained with molding sands of this invention is shown, containing different percentages of hollow microspheres of aluminum silicate, the curves corresponding to the tensile strength at the exit of the box, after 24 hours and with a relative humidity of 100% being represented.

DETAILED DESCRIPTION OF THE INVENTION

The invention provides a molding sand for casting incorporating hollow microspheres of aluminum silicate at an

amount between 1 and 30% by weight with respect to the total amount of sand, preferably between 5 and 25% and more preferably, between 10 and 20%, by weight.

Preliminary tests intended to prevent the formation of "veining" on the iron casting surface showed the possibility of using hollow microspheres of aluminum silicate as an additive for molding sands destined to manufacture cores and chill molds.

Further tests permitted the verification that good results are obtained when the hollow microspheres of aluminum silicate used have an aluminum content between 15 and 45% by weight, based on the weight of the hollow microspheres of aluminum silicate, preferably between 20 and 35% by weight.

For their use in this invention, all kinds of hollow microspheres of aluminum silicate may be used, preferably those satisfying the aforementioned characteristics, such as those marketed by the PQ Corporation under the trade mark Extendospheres, and those marketed by Microfine Minerals Limited under the trade mark Metaspheres 50. In Table 1, the main characteristics of the different microspheres used in the tests carried out are indicated.

Contrary to that expected, it was surprising to verify that the hollow microspheres of aluminum silicate of the best quality, understanding as such those microspheres with a relatively high aluminum content, typically between 35 and 45% by weight, give worse results than when hollow microspheres of aluminum silicate of less quality are used, that is, with an aluminum content less than 35% by weight.

The tests performed with different hollow microspheres of aluminum silicate, incorporated at different proportions to the molding sand have shown that, surprisingly, the microspheres with a low content in aluminum (25-33%) give, in general, the best results regarding "veining" and penetration, in turn maintaining the mechanical properties of the core obtained, moreover observing that an increase in the percentage of aluminum in the microspheres does not imply an improvement in the results of said effects ("veining" and penetration), but, on occasions, the opposite occurs [see Table 5, (Example 5)].

Moreover, the studies performed showed that the best results regarding veining and penetration do not only depend on the aluminum content, but other factors also have an influence, such as the size of the microspheres and the thickness of their walls. Particularly, it has been observed that hollow microspheres of aluminum silicate are suitable having a wall thickness between 3 and 10% of the microsphere diameter and a particle size between 10 and 350 micrometers (μm).

As may be seen in Table 4 (Example 4), the microspheres giving the best results are those identified as Metaspheres 50 and Extendospheres SG, since they have a crushing strength of 189.37 kg/cm^2 (2.700 psi) with an aluminum content between 25 and 30% by weight, a wall thickness of 5%, with respect to the particle diameter (Extendospheres SG) and from 3 to 7% with respect to the diameter of the particle (Metaspheres 50), and an average particle size of 150 μm (Extendospheres SG) and between 10 and 250 μm (Metaspheres 50).

The molding sand of the invention may also contain other conventional components, like casting aggregates, binders and other optional components used in this sector of the technique.

The invention also provides a process to manufacture a core or chill mold by means of a cold process comprising:

(A) introducing the molding sand, purpose of this invention, into a mold to form a core or non-cured mold;

(B) placing said core or non-cured mold of stage (A) into contact with a gaseous cured catalyst;

(C) permitting said core or non-cured mold resulting from stage B) to cure until said core or mold may be handled; and

(D) separating said core or mold from the mold.

In another embodiment, the invention also provides a process to manufacture iron casting comprising:

(A) inserting the core or mold manufactured from the molding sand, purpose of this invention, in a casting device;

(B) pouring the metal, in a liquid state, in said casting device;

(C) letting the metal poured into the casting device cool and solidify; and

(D) separating the molten metal piece from the casting device.

The following examples serve to illustrate the invention. In Table 1, the main characteristics of the hollow microspheres of aluminum silicate used in the execution of these examples are shown.

Table 1

Characteristics of different hollow microspheres of aluminum silicate

Product	Aluminum content (%)	Wall thickness	Particle size (μm)	Crushing resistance (kg/cm^2)	Softening point (°C)
Extendospheres SLG	43,3	= 10% Ø	10-300	562,48	1.800
Extendospheres SL180	43,3	= 10% Ø	10-180	562,48	1.800
Extendospheres SL150	43,3	= 10% Ø	10-150	562,48	1.800
Extendospheres SG	25-30	= 10% (radio)	10-300 (media 130)	189,37	1.200-1.350
Extendospheres XEG	25-30	= 10% (radio)	10-350 (media 162)	189,37	1.200-1.350
Extendospheres X0L200	15		100 (media)	7,03	1.000
Metaspheres 50	26-33	3-7% Ø	10-250	196,8-1.968,1	1.200-1.350

Extendospheres is a trade mark of The Pq Corporation

Metaspheres is a trade mark of Microfine Minerals Ltd.

EXAMPLE 1

Study of the use of hollow microspheres of aluminum silicate as an additive for molding sands

To assess the possible use of hollow microspheres of aluminum silicate as an additive for molding sands, destined to manufacture casting cores, on the one hand some cores were formed using different resins and conventional additives, and on the other hand, other cores from a molding sand, to which hollow microspheres of aluminum silicate had been added, then studying "veining" and the tensile strength of the cores obtained. The techniques used to manufacture the different cores were conventional for each case.

The distinctive components for the different mixtures used to manufacture the cores, are summarized below (Table 2). In all the cases, 2% resin was used. The catalyst used in preparation 02 and 03 was SO_2 (gas) whilst in the remaining preparations, the catalyst used was gaseous methylethylamine (DMEA).

Table 2

Starting mixtures

Preparation	Resin	Molding sand
01	Phenolic urethane	Silica sand (*)
02	Epoxy acrylic	Silica sand (*)
03	Acrylic	Silica sand (*)

Table 2 (cont.)

Preparation	Resin	Molding sand
04	Phenolic urethane	Silica sand (*) + 10% hollow microspheres of aluminum silicate (invention)
05	Phenolic urethane	Recovered furanic sand
06	Phenolic urethane	70/30 silica sand (*)/Chromite
07	Phenolic urethane	50/50 silica sand (*)/Chromite
08	Phenolic urethane	Silica sand (*) + 2% BR-022
09	Phenolic urethane	Silica sand (*) + 2% coal
10	Phenolic urethane	seggar clay
11	Phenolic urethane	50/50 electrofused silica
12	Phenolic urethane	treated olivine
13	Phenolic urethane	Thermally recovered sand
14	Phenolic urethane	Silica sand (*) + 10% Veinseal 14000

(*): Silica sand AFA=50 rounded type, %Si>97%

Once the piece was prepared, the results were studied giving the value "10" to the maximum value of "veining" and a value "0" to the minimum value of "veining". Besides "veining", tensile strength was evaluated.

In Figures 1 and 2, bar diagrams are shown indicating the "veining" effect and tensile strength of the cores obtained. In the position 04, the properties obtained with the core obtained from molding sand containing microspheres of aluminum silicate at a percentage of 10% are shown, it being possible to observe the total absence of the "veining" effect and some good tensile strength properties.

EXAMPLE 2

Density of different cores

The density of different cores obtained according to different manufacturing techniques has been determined including, for comparative purposes, a core manufactured from a molding sand containing hollow microspheres of aluminum silicate, purpose of this invention. The cores, whose density has been evaluated were prepared using the sands and additives listed below:

[1]: Additives of titanium oxide [US 4.735.973] (Veinseal).
[2]: Hollow microspheres of aluminum silicate (Invention).
[3]: Rounded silica.
[4]: Sub-angular silica.
[5]: 70/30 Rounded silica/chromite.
[6]: 90/10 Silica/Additive of titanium oxide [US 4.735.973] (Veinseal).
[7]: 90/10 Silica/Hollow microspheres of aluminum silicate (Invention).

The results obtained are shown in Figure 3, where it may be appreciated that the cores manufactured from molding sands containing hollow microspheres of aluminum silicate, have a very reduced density with respect to that of the other cores, a density permitting the reduction of gas production and penetration in the piece obtained.

EXAMPLE 3

Comparative example

Some cores were prepared as from some molding sands containing different amounts (0, 5%, 10% y 20%) of an additive selected between:

(i) hollow microspheres of aluminum silicate, and

(ii) additives of titanium oxide according to the North American Patent US 4.735.973 (Veinseal), and the effect of the same, both on "veining" and penetration has been evaluated.

The cores were prepared by mixing the sand (C-55) with 0.5%, 10% or 20% by weight of the additive in question and to the resulting mixtures, the suitable resins were added, formed and cured.

Once the different pieces were prepared, the results were evaluated, giving the value "10" to the maximum level of "veining" and penetration and the value "0" to the minimum level of "veining" and penetration. To determine the penetration of the metal in the mold, the test "Penetration 2 x 2 test casting" [AFS Transactions] was used, in which the cavities of the core in the test mold were visually examined for the existence of metal penetration.

The results obtained are shown in Figure 4, where it is clearly seen that the "veining" in both techniques is very similar and is gradually reduced until it disappears when the percentage of additive gradually increases until reaching 10%. However, the penetration using additives of titanium oxide increases as the percentage of additive increases, whilst when using hollow microspheres of aluminum silicate as an additive, the penetration remains constant and at a very reduced level.

EXAMPLE 4

Preparation of cores using hollow microspheres of aluminum silicate as an additive

Some cores were prepared (crushing trials) consisting of molding sand, to which different amounts (0.5%, 10% and 20%) of hollow microspheres of aluminum silicate had been added, and the incidence thereof on the tensile strength of the cores obtained was evaluated.

The test pieces were prepared by mixing the sand (C-55) with 0.5%, 10% or 20% by weight of some hollow microspheres of aluminum silicate and to the resulting mixture, the appropriate resin mixture was added. With the mixture obtained, the crushing trials were prepared which were cured with the suitable gas.

The results obtained are collected in Figure 5, where the tensile strength of the cores obtained with different percentages of the additive, purpose of the invention, are shown, representing the curves corresponding to the tensile strength at the exit of the box, after 24 hours and with a relative humidity of 100%.

By means of a process similar to the above, some cores were prepared as from the molding sands indicated in Table 3, obtained by mixing the sand (C-55) with 0.5%, 10% or 20% by weight of hollow microspheres of aluminum silicate. In all cases, 1% Isocure® 325 (Ashland) resin and 1% Isocure® 625 (Ashland) resin, and DMEA as a catalyst were used.

Table 3

Molding sands

Composition	C-55 sand (% by weight)	Additive (% by weight)
I	100	0
II	95	5
III	90	10
IV	80	20

The cores obtained were submitted to some abrasion resistance tests (Scratch Hardness, SH) and tensile strength tests (Tensile Hardness, TS). The results obtained are shown in Table 4.

Table 4

Mechanical resistances

Resistance composition	I		II		III		IV	
	TS	SH	TS	SH	TS	SH	TS	SH
2 cc. 302	68	94	56	93	54	92	44	90
1 hour	76	95	72	94	74	96	60	92
24 hours	88	98	95	97	98	97	85	96
1 h. Air and 24 h. 100% humidity	23	73	35	86	30	79	26	74
Test piece weight	448,9		425,0		385,8		318,8	

The following examples were made with the purpose of selecting the most suitable hollow microspheres of aluminum silicate for their use as an additive in molding sands.

EXAMPLE 5

Evaluation of different hollow microspheres of aluminum silicate as an "anti-veining" additive

To evaluate the "anti-veining" behavior of different types of microspheres of aluminum silicate, some test pieces for crushing tests were prepared, consisting of molding sand to which different amounts of the microspheres to be evaluated had been added.

The test pieces were prepared by mixing the sand (C-55) with 10% or 20% by weight of the microspheres and to the resulting mixture 0.75% Isocure® 325 (Ashland) and 0.75% Isocure® 625 (Ashland) were added. With the mixture obtained, some test pieces for crushing were made, gassing them with Isocure® 720 (Ashland). Afterwards, they were placed in a mold for their melting with gray iron at 1,420°C.

Once the piece had been cooled, the results were evaluated, giving the value "10" to the maximum level of "veining" and penetration and the value "0" to the minimum level of "veining" and penetration. To determine the penetration of the metal in the mold, the test "Penetration 2 x 2 test casting" [AFS Transactions] was used, in which the cavities of the core were examined in the test mold to visually examined the existence of metal penetration.

The results obtained are shown in Table 5, where it may be appreciated that the best results regarding "veining" and penetration (that is, those in which "veining" and penetration was obtained with a value of zero or very near to zero) were obtained when using 20% by weight of the hollow microspheres of aluminum silicate with an aluminum content between 25 and 33% (Extendospheres SG and Metaspheres SLG, SL180 and SL150, with an aluminum content near to 45% by weight) which gave the worse results in general.

Table 5

Study of "anti-veining" products

Test pieces for crushing

Isocure® 325/ Isocure® 625 (1.5% resin total)

Test piece No.	C-55 sand	Test piece weight (g)	SL 180	SL 150	SLG	Meta. 50	XEG	SG	XOL 200	Veining	Penetration
Control A	100	175,8	--							8	2
1	90	151,5	10	--	--	--	--	--	--	9	2
2	80	122,2	20	--	--	--	--	--	--	9	2
3	90	150,1	--	10	--	--	--	--	--	9	2
4	80	124,3	--	20	--	--	--	--	--	9	4
5	90	147,2	--	--	10	--	--	--	--	9	1
6	80	121,0	--	--	20	--	--	--	--	10	0
7	90	150,0	--	--	--	10	--	--	--	4	3
8	80	123,2	--	--	--	20	--	--	--	0	0
9	90	144,6	--	--	--	--	10	--	--	2	2
10	80	117,0	--	--	--	--	20	--	--	0	1
11	90	147,0	--	--	--	--	--	10	--	2	0
12	80	122,0	--	--	--	--	--	20	--	0	0
13	90	175,4	--	--	--	--	--	--	10	9	2
14	95	176,0	--	--	--	--	--	--	5	10	5

[SL 180, SL150, SLG, XEG, SG and XOL200 are different types of Extendospheres; Meta. 50: Metaspheres 5°; (Table 1)]

EXAMPLE 6

Evaluation of the mechanical resistance of "anti-veining" additives

To evaluate the mechanical resistance of different types of microspheres of aluminum silicate, some tensile strength test pieces were prepared, consisting of sand to which different amounts of the microspheres to be evaluated had been added.

The test pieces were prepared by mixing the sand (C-55) with 10% or 20% by weight of the microspheres and to the resulting mixture, 0.75% Isocure® 325 (Ashland) and 0.75% Isocure® 625 (Ashland) were added. The catalyst used was DMEA. With the mixture obtained, some tensile strength test pieces were made, which were subjected to abrasion resistance (SH) and tensile strength (TH) tests. The result obtained are shown in Table 6, where it is observed that in spite of the good results obtained in the "veining" and penetration effects, also satisfactory mechanical resistances were obtained, for the cores prepared from the molding sands of the invention.

Table 6

Study of the mechanical resistances of agglomerated products (sand/microspheres)

Resin / Amount Catalyst	ISOCURE® 325 ISOCURE® 625 1.5 DMEA		ISOCURE® 325 ISOCURE® 625 1.5 DMEA		ISOCURE® 325 ISOCURE® 625 1.5 DMEA		ISOCURE® 325 ISOCURE® 625 1.5 DMEA		ISOCURE® 325 ISOCURE® 625 1.5 DMEA		ISOCURE® 325 ISOCURE® 625 1.5 DMEA	
Product Agglomerate	100% C-55 (Control)		90% C-55 10% EX XEG		80% C-55 20% EX XEG		90% C-55 10% EX SG		80% C-55 20% EX SG		80% C-55 20% MS 50	
	TS	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**
3 cc. 3'	50	92	67	92	56	90	63	92	57	91	50	90
1 hour	73	96	72	94	58	91	70	93	59	93	48	73
24 hours	83	97	78	94	63	92	86	95	73	95	66	87
1h air & 24 h 100% humidity	60	94	61	89	59	90	70	93	60	90	49	83
Density 3 test pieces	228.3		186.0		153.3		192.3		156.0		156.0	
6 hours of life in bank												
	TS	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**
3cc. 3'	38	83	40	81	25	43	38	80	22	49	15	32
1 hour	46	91	44	83	26	44	40	82	25	49	12	31
24 hours	55	94	48	86	30	47	48	85	29	50	13	40
1h air & 24 h 100% humidity	48	92	38	81	23	40	44	81	20	40	11	32

[MS: Metaspheres; EX: Extendospheres; TS: tensile strength; SH: abrasion resistance]

EXAMPLE 7

Evaluation of mechanical resistances of different hollow microspheres of aluminum silicate

To evaluate the mechanical resistance of different hollow microspheres of aluminum silicate at 100%, some tensile strength test pieces were prepared, by mixing the microspheres (100%) to be evaluated with 3% Isocure® 323 (Ashland) and 3% Isocure® 623 (Ashland). With the mixtures obtained, some tensile strength test pieces were made which were gassed with Isocure® 702 (Ashland). The test pieces obtained were submitted to abrasion resistance (SH) and tensile strength (TH) tests. The result obtained are shown in Table 7, where it may be appreciated that the best results were obtained with Extendospheres XEG microspheres, having an average particle size (162 µm) greater than the Extendospheres SG microspheres (130 µm).

Table 7

Study of mechanical resistances of different additives (with Isocure) used in the manufacture of sleeves

Microsphere	EX SL180		EX SL150		EX SLG		METASPHERES 50		EX SG		EX XEG	
Resin	ISOCURE 323/623		ISOCURE 323/623		ISOCURE 323/623		ISOCURE 323/623		ISOCURE 323/623		ISOCURE 323/623	
Resin amount	6		6		6		6		6		6	
Catalyst	DMEA		DMEA		DMEA		DMEA		DMEA		DMEA	
	TS	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**	**TS**	**SH**
4 cc. 3'	49	80	49	82	47	78	48	81	36	71	60	83
1 hour	63	86	52	84	66	87	43	80	50	80	66	83
24 hours	70	92	67	86	67	90	40	79	72	94	78	95
1h air & 24 h 100% humidity	60	85	43	77	63	87	38	75	54	79	63	94

[Ex: Extendospheres; TS: tensile strength; SH: abrasion resistance]

Claims

1. A molding sand for casting including hollow microspheres of aluminum silicate.

2. A sand, according to claim 1, wherein said hollow microspheres of aluminum silicate have an aluminum content between 15 and 45% by weight, of the microspheres.

3. A sand according to claim 2, wherein said hollow microspheres of aluminum silicate have an aluminum content between 20 and 35% by weight.

4. A sand according to claim 1, wherein said hollow microspheres of aluminum silicate have a wall thickness between 3 and 10% of the microsphere diameter.

5. A sand according to claim 1, wherein said hollow microspheres of aluminum silicate have a particle size between 10 and 350 μm.

6. A sand according to claim 1, comprising between 1 and 30% by weight of hollow microspheres of aluminum silicate, with respect to the total amount of sand.

7. A sand according to claim 6, comprising between 5 and 25% by weight of hollow microspheres of aluminum silicate with respect to the total amount of sand.

8. A sand according to claim 7, comprising between 10 and 20% by weight of hollow microspheres of aluminum silicate with respect to the total amount of sand.

9. A process to manufacture a core or chill mold by means of cold process, comprising:

   (A) introducing a molding sand according to any of the claims 1 to 8, in a mold to form a core or non-cured mold;

   (B) putting said core or non-cured mold of the stage (A) in contact with a gaseous cured catalyst;

   (C) letting said core or non-cured mold resulting from the stage (B) cure until said core or mold may be handled; and

   (D) separating said core or mold from the mold.

10. A core or chill mold prepared according to the process of claim 9.

11. A process to manufacture iron casting, including:

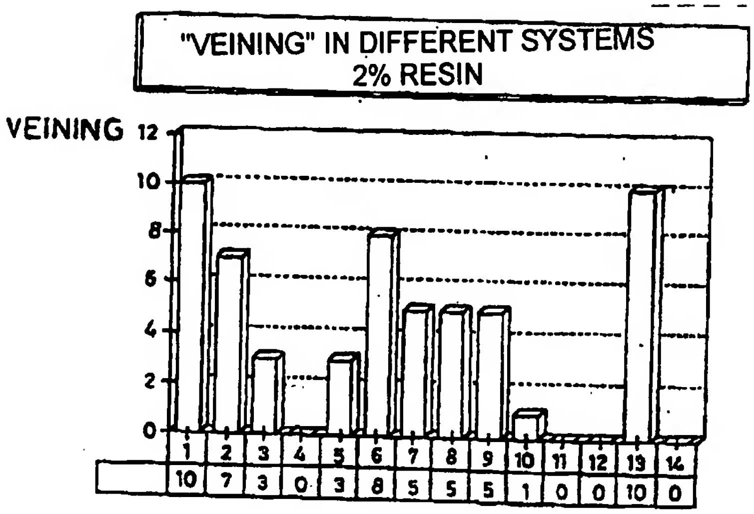
   (A) inserting a core or chill mold, according to claim 10 in a casting device;

   (B) pouring the metal in a liquid state, in said casting device;

   (C) letting the metal poured into the casting device cool and solidify; and

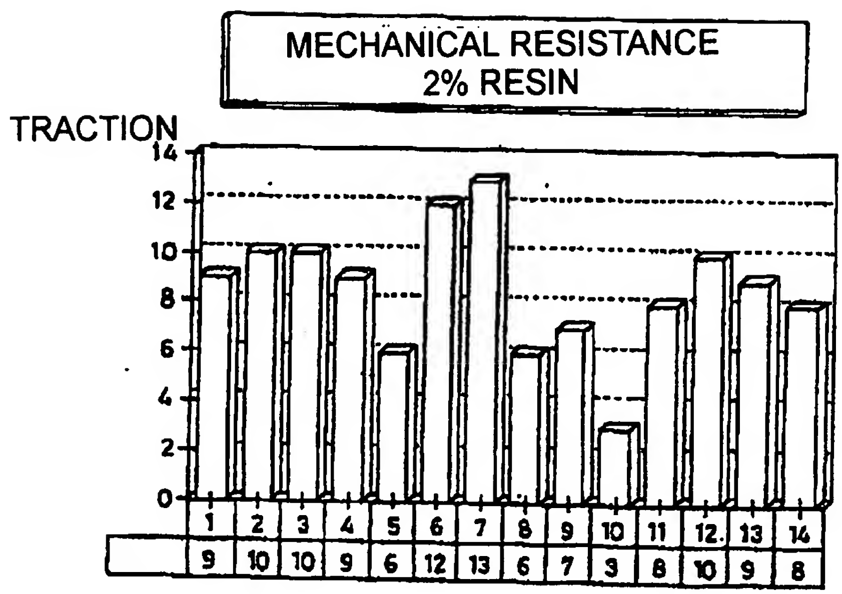
   (D) separating the melted metal piece from the casting device.

12. An iron casting prepared according to the process of claim 11.



01.- Phenolic Urethane.
02.- Epoxy acrylic
03.- Acrylic
04.- Silica + 10% microsphere additive, purpose of the invention
05.- Furamic recovered sand
06.- 70/30 silica/chromite
07.- 50/50 silica/chromite
08.- Silica + 2% BR-022
09.- Silica + 2% coal.
10.- Seggar clay
11.- 50/50 electrofused silica
12.- Treated olivine
13.- Thermally recovered sand
14.- Silica + 10 Veinseal 14000

FIG.1



01.- Phenolic Urethane
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09.- Silica + 2% coal
10.- Seggar clay
11.- 50/50 electrofused silica
12.- Treated olivine
13.- Thermally recovered sand
14.- Silica + 10 Veinseal 14000

FIG.2

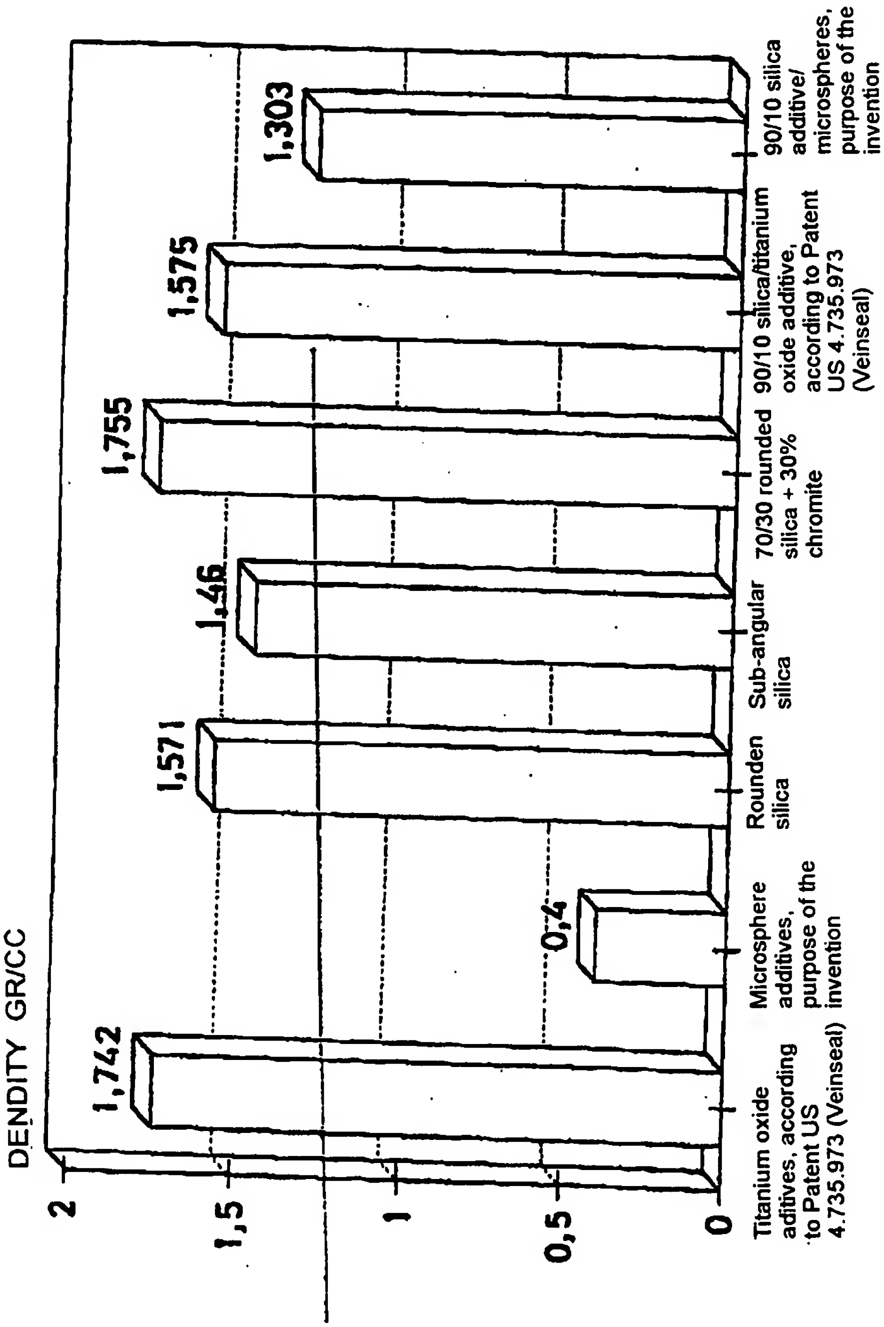
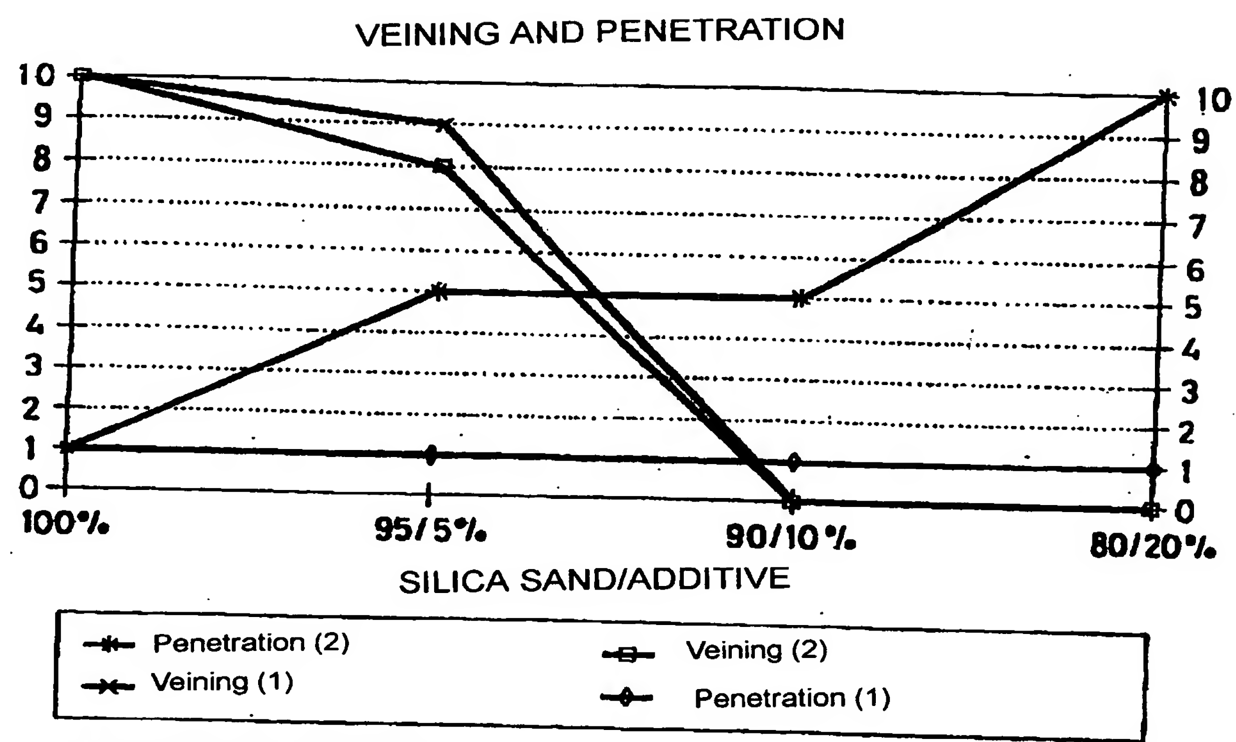

DENDITY GR/CC
2
1,5
1
0,5
0
1,742
0,4
1,571
1,46
1,755
1,575
1,303
Titanium oxide aditives, according to Patent US 4.735.973 (Veinseal)
Microsphere additives, purpose of the invention
Rounden silica
Sub-angular silica
70/30 rounded silica + 30% chromite
90/10 silica/titanium oxide additive, according to Patent US 4.735.973 (Veinseal)
90/10 silica additive/ microspheres, purpose of the invention

FIG.3



(1)MICROSPHERE ADDITIVE, PURPOSE OF THE INVENTION

(2) TITANIUM OXIDE ADDITIVE, ACCORDING TO PATENT US 4.735.973

FIG.4

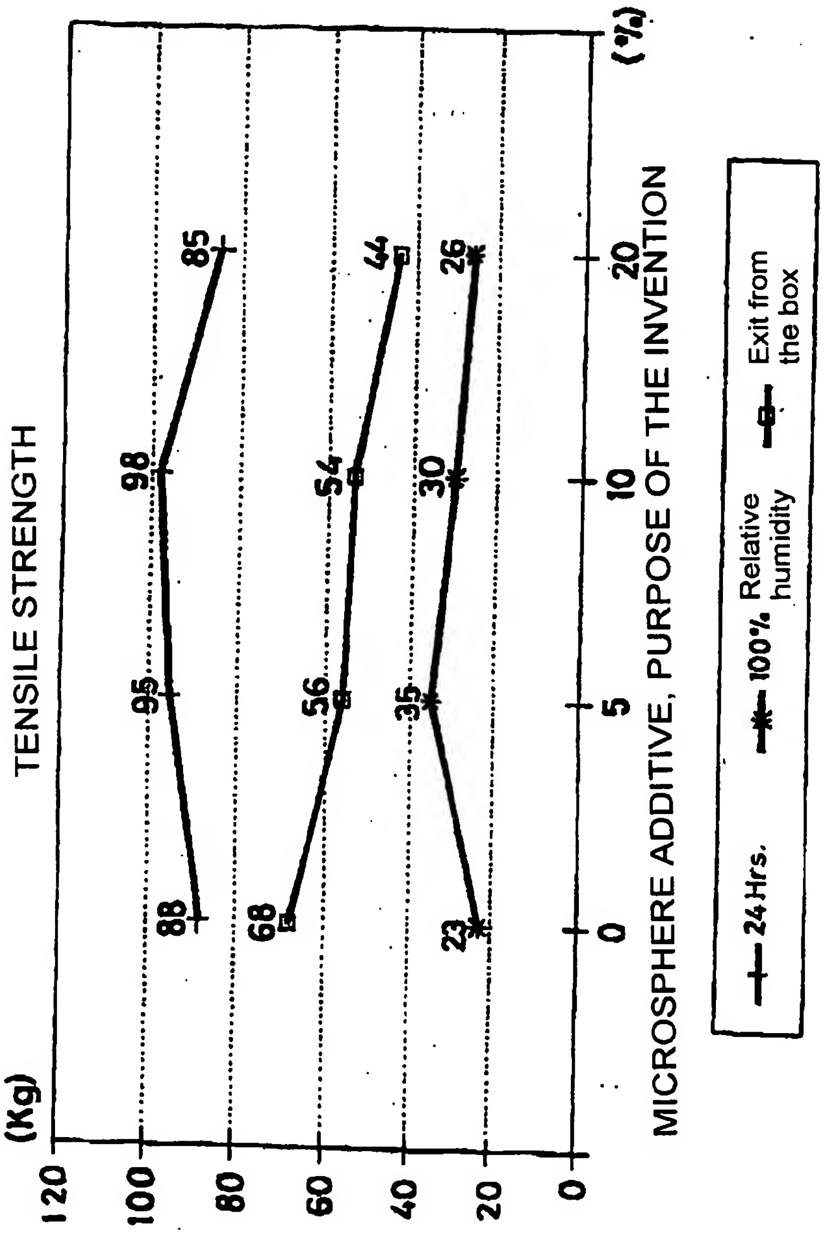

TENSILE STRENGTH
(Kg)
120
100
80
60
40
20
0
88
95
98
85
68
56
54
44
23
35
30
26
0
5
10
20
(%)
MICROSPHERE ADDITIVE, PURPOSE OF THE INVENTION
24 Hrs.
100% Relative humidity
Exit from the box

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES 97/00314

A. CLASSIFICATION OF SUBJECT MATTER

IPC^6: C04B 35/18, 38/08, B22C 1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^6

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, TXTE, CIBEPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9423865 A (FOSECO INTERNATIONAL LIMITED), 27 October 1994 (27.10.94), page 1, lines 1-16; page 5, lines 15-20; claims 1,6,8,10,11,12,13	1-12
X	US 4874726 A (KLEEB ET AL.), 17 October 1989 (17.10.89), column 2, lines 14-32	1-8
X	US 5443603 A (KIRKENDALL), 22 August 1995 (22.08.95), column 4	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 1998 (23.03.98)	31 March 1998 (31.03.98)
Name and mailing address of the ISA/ S.P.T.O. Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

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